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SINGLE OBJECTIVE CRITERIA FOR SELECTION OF MANUFACTURING METHOD

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ABSTRACT

In order to improve the manufacturing cycle more than 110 manufacturing processes have been proposed. The objectives aimed at and the functions focused on by these processes vary. The process should be able to meet daily production requirement, which at the same time should utilize full capacity of the machine and its tooling and should reduce to a minimum idle operator and idle machine time and must provide the maximum utilization of minimum amount of material. The process should be flexible enough to accommodate reasonable changes in design. This poses a great challenge to a manager in selection of effective and economical manufacturing process. Different organizations have different objectives and based on their specific requirement they deploy suitable process conforming to their objective. Based on their needs, the weights assigned to the objectives vary. Today's business scenario is highly competitive, complex and dynamic in nature which demands strategic planning meeting the challenges of changing time. In this paper we have made an attempt to enable the end user a quick selection of appropriate manufacturing method based on a single objective. A tool is developed for the purpose which provides two different types of interfaces to an end user. One interface is GUI based which is user friendly and provides a simple drag and drop operation for the selection of manufacturing methods based on a single objective and a method classification. The second method is command-line interface enabling the end user to query the database using Manufacturing Query Language (MQL) designed by us. Parse tree is developed and text parsing is used for parsing the query. The query language is designed for the manufacturing domain and renders the end user free from the intricacies involved in SQL syntax involving filtering, joins etc. MQL currently comprises of few commands which can be queried by the end user for the selection of manufacturing methods based on a single objective and a method classification. It is subject to future enhancements. Our current work focuses on a single objective. It is an idealistic scenario where a single objective defines the selection of manufacturing method. In real situations multi objective criteria is required for the purpose. Nevertheless this is our first attempt towards development of such tool and our future work involves modification of the tool and parser to take account of multiple objectives and functions.

KEYWORDS: Class Method, Formal Grammar, Manufacturing Objective, Manufacturing Query Language, Parser

INTRODUCTION

Manufacturing methods include methods of many different types. Some of the methods are of a technological nature, while others are organizational and architectural, and yet others focus on information technology. Some are of a practical nature while others are of a philosophical nature. To assist managers in selecting the best method to achieve certain criteria, two mapping methods are available, one based on the objectives of the method and the other based on the

functions that the methods may serve. Based on the maturity of the manufacturing company, a particular manufacturing method may focus on manufacturing hardware, auxiliary software support, production planning and control, next generation production management, processing manufacturing methods, commercial aspects, organization, advanced organizational manufacturing methods, design methods, human factors in manufacturing, environmental manufacturing methods, or cost and quality manufacturing methods. Giden Halevi has presented a review of manufacturing methods and their objectives [1]. The author has listed 110 published manufacturing methods which fall in 5 different classes based on their nature. In this paper we consider the following objectives as proposed by Giden Halevi in selection of a particular manufacturing method.

- Meeting delivery dates
- Reduce production costs.
- Rapid response to market demands
- Reduce lead time
- Progress towards zero defects
- Progress towards zero inventory
- Improve management knowledge and information
- Improve and increase team work collaboration
- Improve customer and supplier relationships
- Improve procurement management and control
- Management strategic planning
- Improve human resources management
- Improve enterprise integration
- Continuous improvement
- Environmental production
- Marketing – market share.

The suitability of each method to a specific objective is graded according to the following grades.

- Excellent for specific dedicated objective
- Very good
- Good
- Fair

This paper focuses on assisting managers to evaluate and select the most appropriate manufacturing method or methods for their needs. Several alternatives may be proposed, allowing the user to decide which one is more suitable

under the circumstances. The user can select the method according to its type. The decision depends on the objectives and the functions considered, and on the grading given to each method. The objectives and grades can be manipulated by the end user.

Objective Grading Table

The structure of the objective grading table is as follows. The objective grading table consists of 110 rows and 19 columns. The first column contains the method number. The second column contains the method initial for verification purposes. The third column contains the method classification. The following 16 columns refer to the 16 objectives. The blank cell indicates that the method in the corresponding row has nothing to do with the objective in the corresponding column.

Selecting the Method Using a Single Objective

The procedure for selecting a manufacturing method using a single objective is as follows:

- Select the column that represents the objective in objective grading table.
- Scan the rows in this column for grades a or b.
- Make an objective table that contains only the methods filtered in step 2.
- Decide which class of method to use
- Narrow down the table constructed in step 3 to those that correspond to the desired class.
- Decide which of the proposed methods is preferred.

LITERATURE SURVEY

There exists a vast amount of literature on manufacturing process monitoring using both crisp and fuzzy logic approach [2,9] which focus mainly on software selection, technology selection and system project selection. Chenhui Shao et.al [10] have developed a novel algorithm for parameter tuning and feature selection. Quality monitoring is used for monitoring a quality of a manufacturing process. Multiple criteria decision making method is employed by R. V. Rao, T. S. Rajesh [11]. The authors have presented a decision making framework using a multiple criteria decision making method viz., Preference Ranking Organization Method for Enrichment Evaluations (PROMETHEE) which has been integrated with analytic hierarchy process (AHP) and the fuzzy logic. The framework enables the manager a software selection in manufacturing industries. Mohammad Akhshabi [12] has developed a Fuzzy Multi Criteria Model for Maintenance Policy which is used for the optimized decision making

PROPOSED ALGORITHM

Pseudo Code

Function findMethodsInClass()

{

/*Create the objective grading table consisting of 110 rows representing manufacturing methods and 16 columns representing the various objectives. */

```
for row=1 to 110
begin
for col = 1 to 16
 begin
     displaygrade(row,col);
 end if;
end if;
```

/* The ijth element represents the grade given to the objective j for the manufacturing method i. If the objective is not applicable to the method under consideration then the cell is left blank. */

/* Read the single objective to be met by the manufacturing method. */

```
Read O.
```

/* Remove from the filtered table all methods that have values 'c' or 'd' in the object column Obj */

```
n=0;
for row=1 to 110
begin
for col = 1 to 16
begin
   if (col=Obj) then
       if ele(row,col)="a" or ele(row,col)="b" then
          n=n+1;
           displaygrade(row,col);
       end if;
   end if;
end;
```

/* n represents the number of filtered methods */

/* Read the class of the method to be used for manufacturing method */

```
Read C.
```

/* Remove from the filtered table all methods that have values other than C in the third column Method Classification */

```
nc=0;
for row=1 to n
```

```
        begin
                for col = 1 to 16
                begin
                 if (col=3 && val(col)='C') then
                        nc=nc+1;
                        displaygrade(row,col);
                end if;
                end;
        end;
/* nc representd the number of methods meeting the objective O and in class C */
/* Print the filtered methods */
        for row=1 to nc
        begin
           Print MethodName;
        end;
}
```

Mathematical Formulation

Let the objective to be met by the manufacturing method be represented by O. Let T denote an objective grading table whose ij^{th} element is given by

a_{ij}= [a|b|c|d|]}1 <= i <= 110 and 1 <= j <= 16. (1)

The filtered table has 110 rows each representing a manufacturing method and 16 columns representing 16 objectives. The indices i and j represent a method number and the objective number of an element in the objective grading table.

Remove from the objective grading table, represented by equ^{n}(1) all the methods that contains the grade c or d in the column objective O. This results in a new filtered table denoted by T´ that contains only the methods with grades a or b in the column objective O. The ij^{th}element of this new table T´ is given by

a_{ij}= [a|b] }, if j=O.

a_{ij}= [a|b|c|d|] }, otherwise. (2)

The row index i is such that, m_k<= i <= $m_p$and

where, $m_k, m_{k+1}, m_{k+2}.....m_p$ represent the method numbers meeting the required objective.

Let C be the class of method to use. Remove from the filtered table T´, represented by equ^{n}(2) all the methods that belong to the class other than C. This results in a new filtered table denoted by T ″ that contains only the methods in the class C. The ijthelement of this new table T ″ is given by

a_{ij}= [a|b] }, if j=O.

a_{ij}= [a|b|c|d|] }, otherwise.

The row index i is such that, m_n<= i <= $m_m$and

where, m_n, m_{n+1}, m_{n+2}.....m_m represent the method numbers meeting the required objective and are in class C.

Manufacturing Query Language (MQL)

A Manufacturing Query Language is designed which enables the end user to query the database in a human language without worrying about tedious SQL syntax. No formal knowledge of SQL is desirable. It provides a layer on top of SQL to render the query language end user friendly. The architecture is depicted in the following Figure 1.

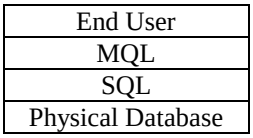


Figure 1: MQL Architecture

Parse Tree for the Selection of the Manufacturing Method Using Single Objective

A concrete syntax tree or parse tree is designed to represent the syntactic structure of the string according to formal grammar. Parse tree is constructed in terms of the dependency relation of dependency grammars. The parser tree for parsing the query in MQL is shown in Figure 2.

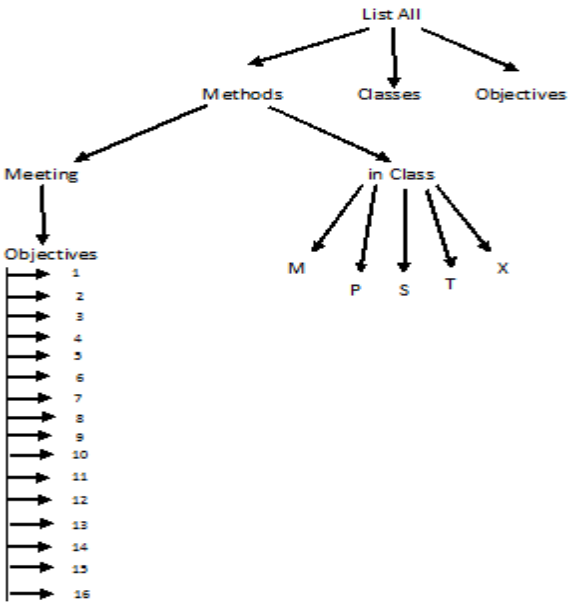


Figure 2: Parse Tree for the Selection of the Manufacturing Method

General Syntax of 'List' MQL Command

A single MQL command viz., List is implemented at present which has the following syntax.

List All {Methods|Objectives|Classes} [Meeting {Objective1|Objective2|…|Objective16}

[in Class {M|P|S|T|X}]]. The following notations are used

{a|b|…} → One clause from the group of clauses separated by | must be selected.

[..] → The clause specified is optional

The above semantics generates the following queries.

- List All Methods
- List All Objectives
- List All Classes
- List All Methods Meeting Objective<n>

  where <n> can take any value between 1 and 16.
- List All Methods Meeting Objective<n> in Class<m>

  where, n is same as above and m takes the values in the range 1 to 5.

RESULTS AND ANALYSIS

The results presented above are implemented in VB with MS-Access as backend for storing method and objective details. The structure of the database is shown in the following Figure 3. A Graphical User Interface (GUI) is presented to the end user to select one of the manufacturing methods from the available alternatives using simple drag and drop operations. All the 16 objectives are listed on the left and 5 classes on the top of the grid as shown in the Figure 4(a). The user can drag and drop any required objective on to a grid to filter the methods aiming at that objective. Figure 4(b) shows a filtered list of methods meeting objective1, i.e. Meeting Delivery Dates. Out of 110 rows 19 rows are selected. Further, the user can drag-and-drop one of the five class methods to further narrow down the table showing the filtered methods in the selected class. This is depicted in figure 4(c) where out of 19 rows listed in figure 4(b), only 6 are selected. Figure 5(a-f) show execution of MQL commands.

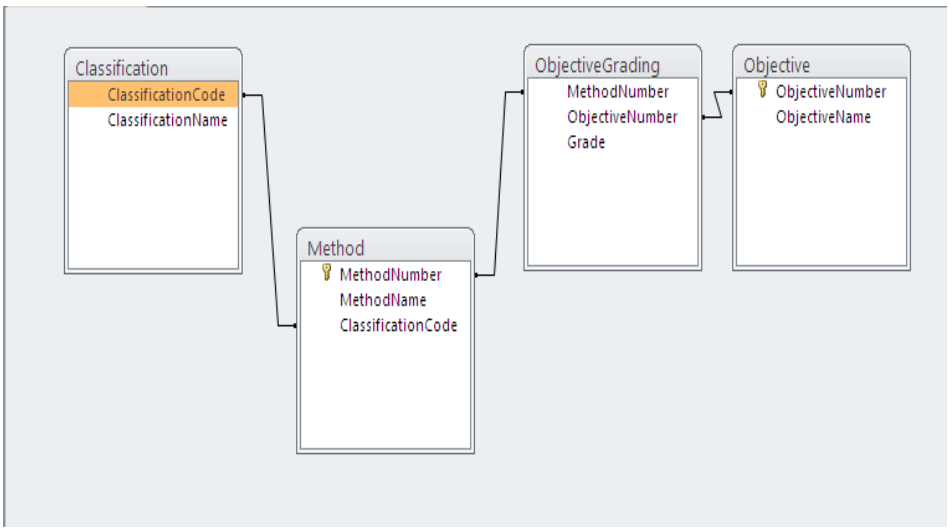


Figure 3: Structure of Database

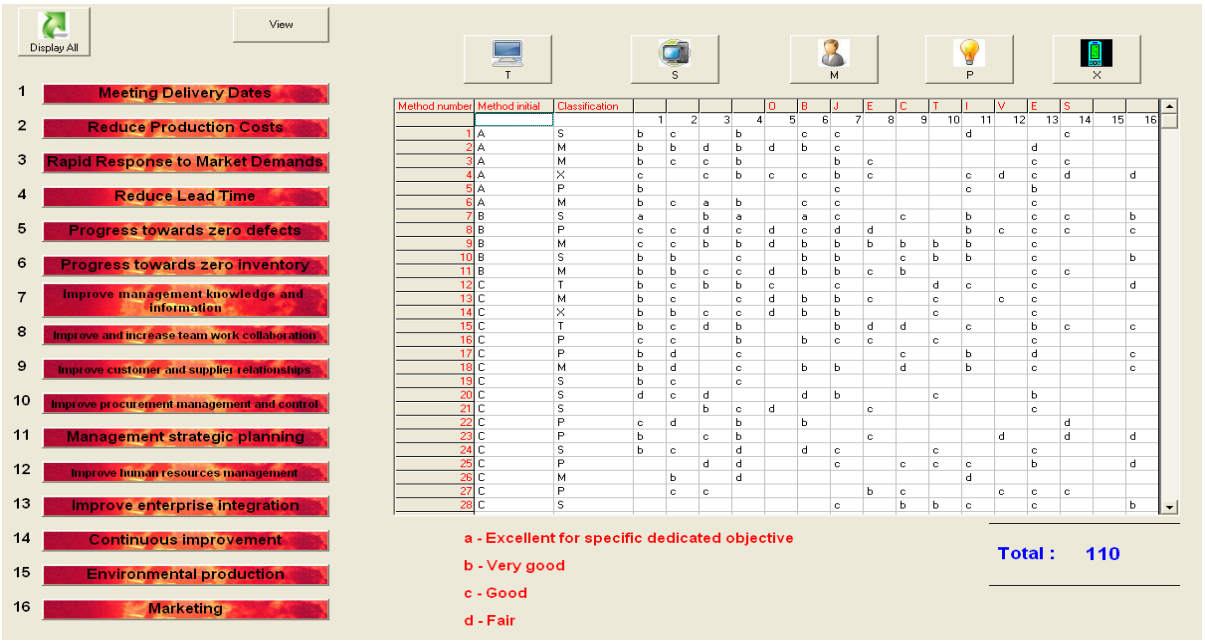


Figure 4 (a)

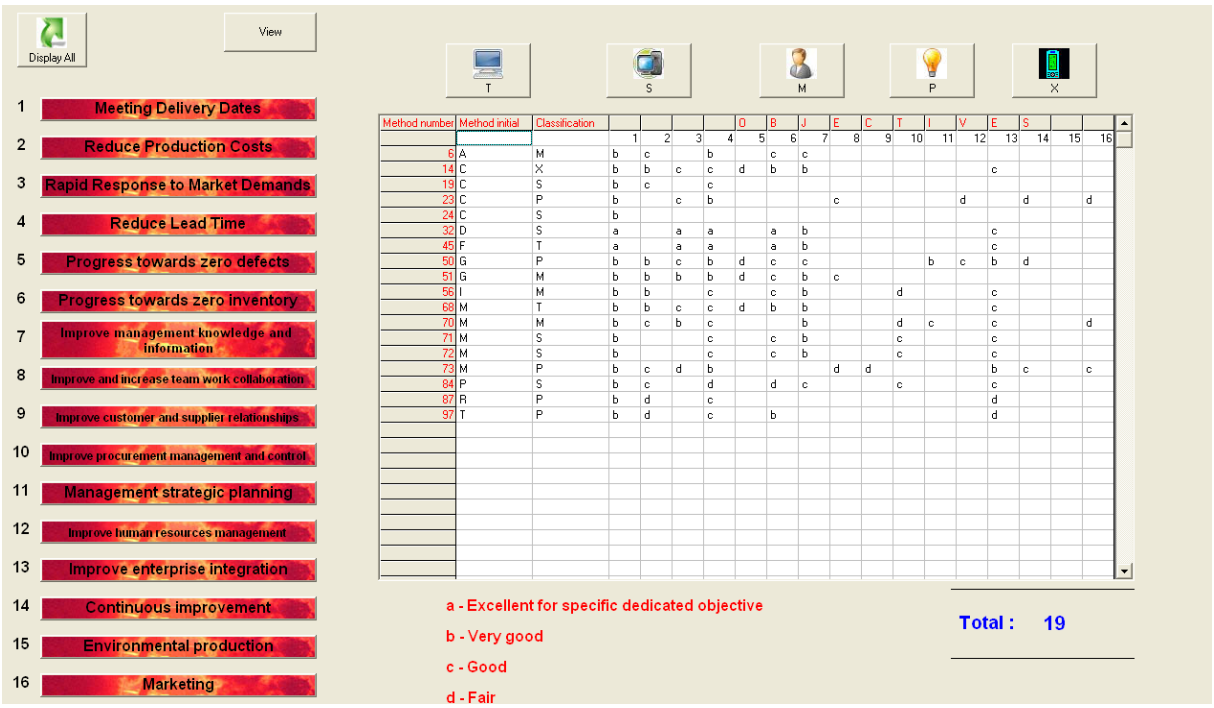


Figure 4 (b)

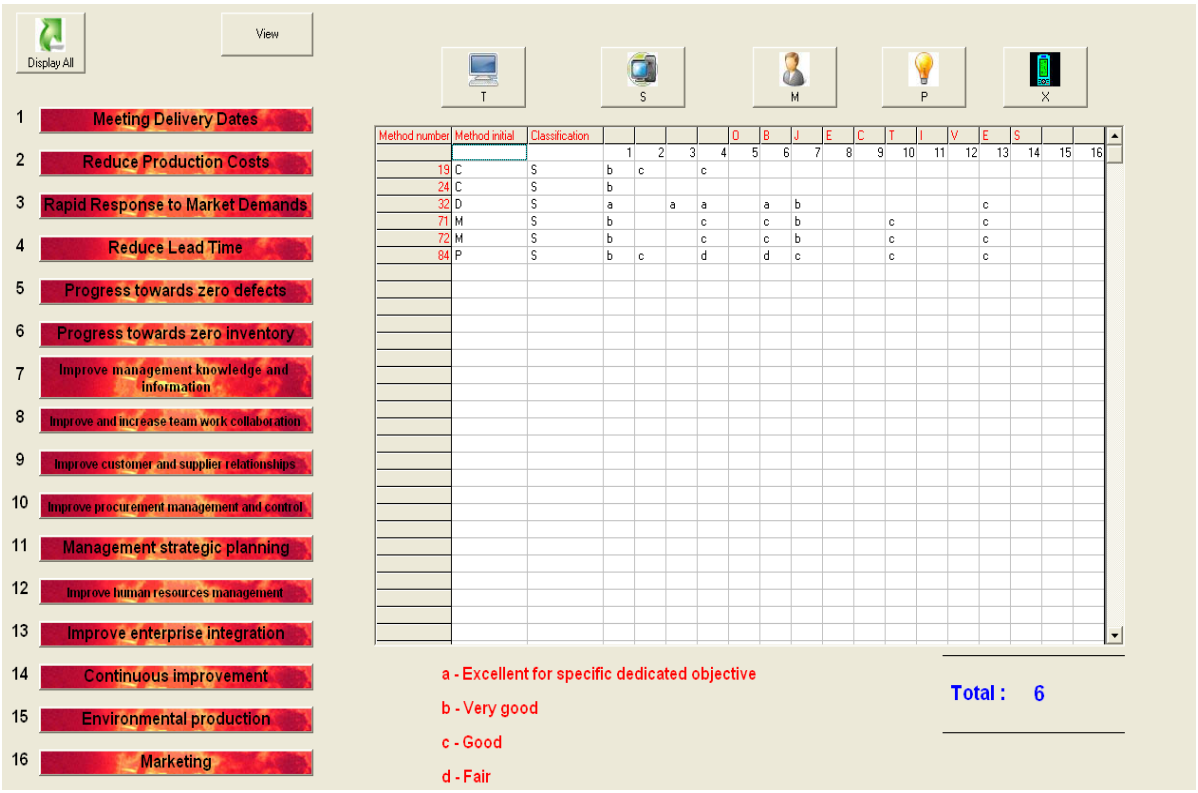


Figure 4 (c)

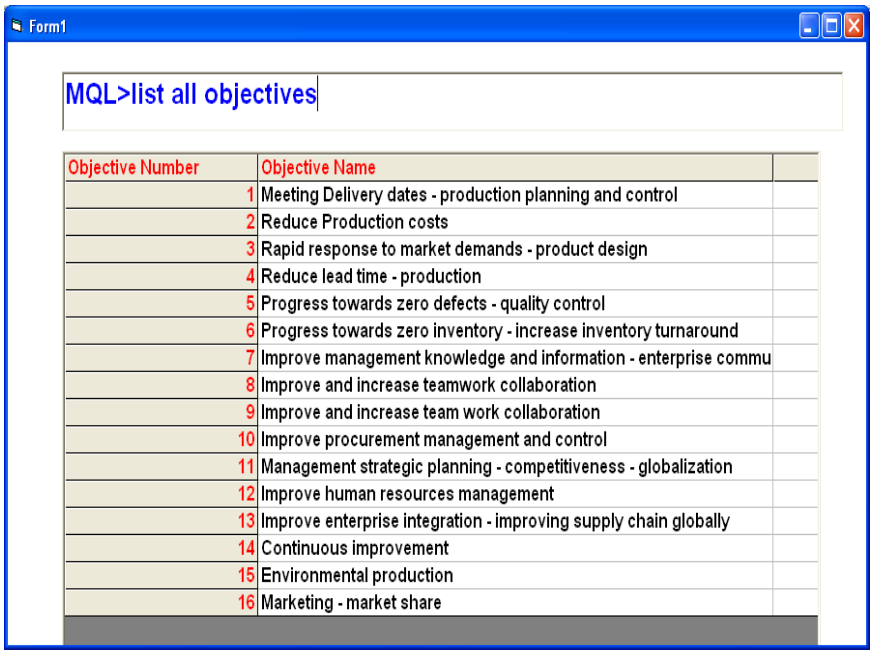
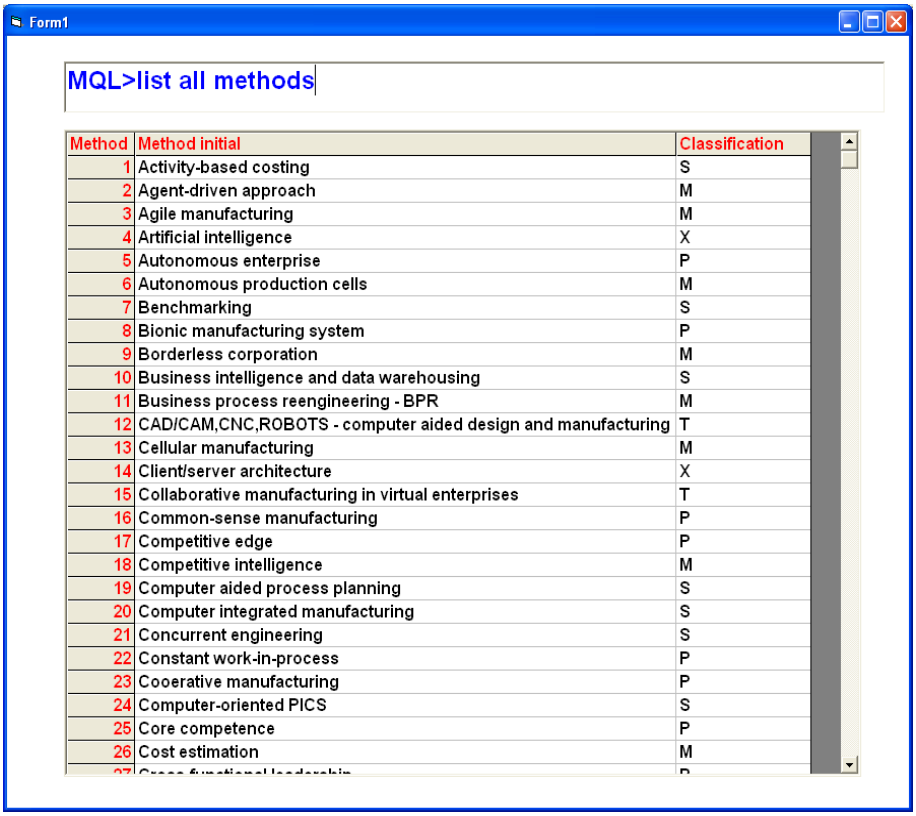
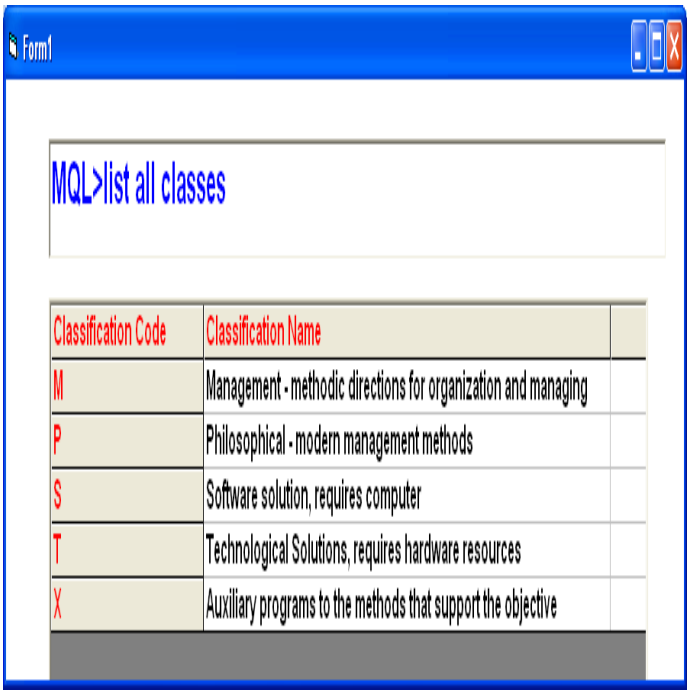


Figure 5 (a)



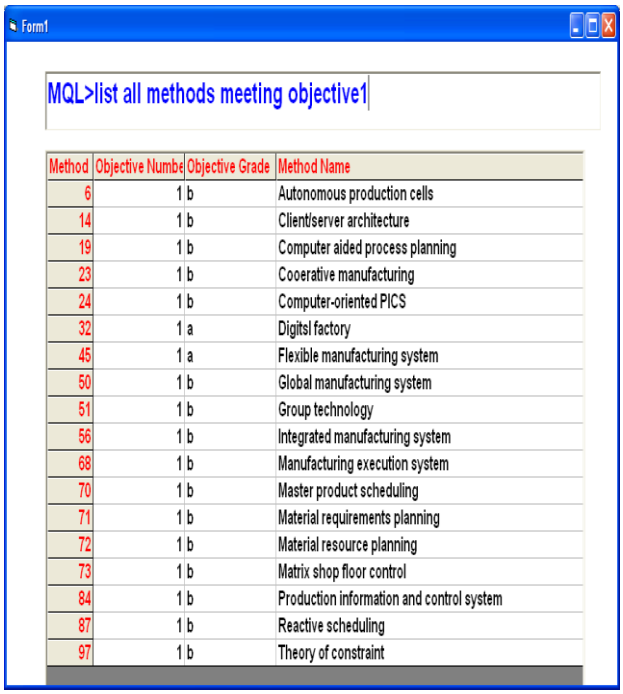
Method	Method initial	Classification
1	Activity-based costing	S
2	Agent-driven approach	M
3	Agile manufacturing	M
4	Artificial intelligence	X
5	Autonomous enterprise	P
6	Autonomous production cells	M
7	Benchmarking	S
8	Bionic manufacturing system	P
9	Borderless corporation	M
10	Business intelligence and data warehousing	S
11	Business process reengineering - BPR	M
12	CAD/CAM,CNC,ROBOTS - computer aided design and manufacturing	T
13	Cellular manufacturing	M
14	Client/server architecture	X
15	Collaborative manufacturing in virtual enterprises	T
16	Common-sense manufacturing	P
17	Competitive edge	P
18	Competitive intelligence	M
19	Computer aided process planning	S
20	Computer integrated manufacturing	S
21	Concurrent engineering	S
22	Constant work-in-process	P
23	Cooerative manufacturing	P
24	Computer-oriented PICS	S
25	Core competence	P
26	Cost estimation	M

Figure 5 (b)



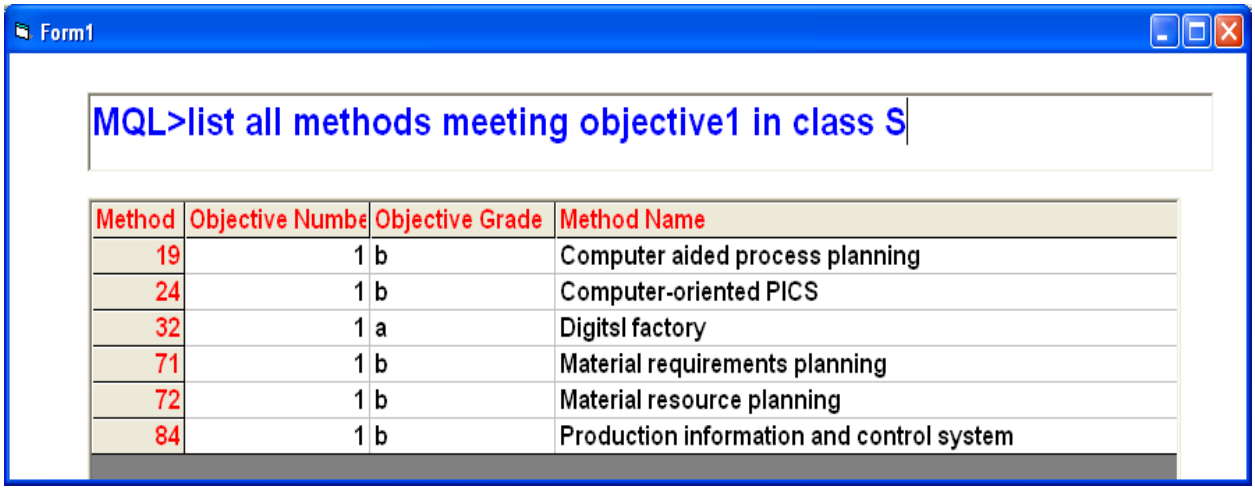
Classification Code	Classification Name
M	Management - methodic directions for organization and managing
P	Philosophical - modern management methods
S	Software solution, requires computer
T	Technological Solutions, requires hardware resources
X	Auxiliary programs to the methods that support the objective

Figure 5 (c)



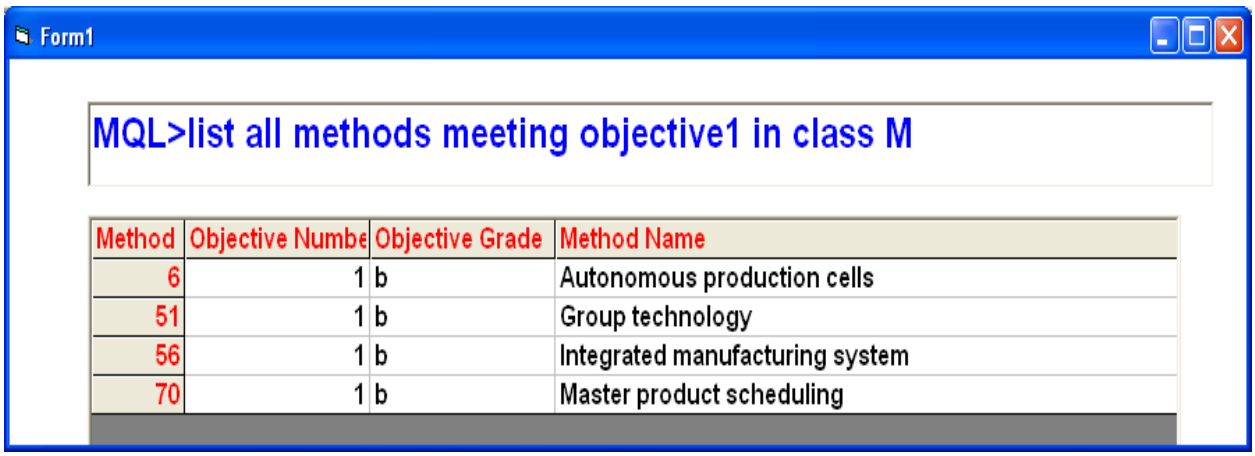
Method	Objective Numbe	Objective Grade	Method Name
6	1	b	Autonomous production cells
14	1	b	Client/server architecture
19	1	b	Computer aided process planning
23	1	b	Cooerative manufacturing
24	1	b	Computer-oriented PICS
32	1	a	Digitsl factory
45	1	a	Flexible manufacturing system
50	1	b	Global manufacturing system
51	1	b	Group technology
56	1	b	Integrated manufacturing system
68	1	b	Manufacturing execution system
70	1	b	Master product scheduling
71	1	b	Material requirements planning
72	1	b	Material resource planning
73	1	b	Matrix shop floor control
84	1	b	Production information and control system
87	1	b	Reactive scheduling
97	1	b	Theory of constraint

Figure 5 (d)



Method	Objective Numbe	Objective Grade	Method Name
19	1	b	Computer aided process planning
24	1	b	Computer-oriented PICS
32	1	a	Digitsl factory
71	1	b	Material requirements planning
72	1	b	Material resource planning
84	1	b	Production information and control system

Figure 5 (e)



Method	Objective Numbe	Objective Grade	Method Name
6	1	b	Autonomous production cells
51	1	b	Group technology
56	1	b	Integrated manufacturing system
70	1	b	Master product scheduling

Figure 5 (f)

CONCLUSIONS AND FUTURE WORK

This paper presents the design of a tool which assists the manager in selection of a manufacturing method based on a single objective. It provides two different types of interfaces, one based on a GUI and second one is a command line interface. A query language is developed to assist the manager to query a database in conventional language. A general syntax and a parse tree of a query language is presented. Our future work focuses on modification of the tool and the query language to incorporate multiple objectives and functions.

REFERENCES

1. Gideon Halevi, Handbook of Production Management Methods, Butterworth Heinemann publications, ISBN 0 7506 5088 5.
2. L. Mikhailov and M. G. Singh, “Fuzzy analytic network process and its application to the development of decision support systems,” IEEE Transactions on Systems, Man, and Cybernetics, Part C. Applications and Reviews, Vol. 33, No. 1, pp. 33–41, 2003.
3. R. Santhanam and G. J. Kyparisis, “A multiple criteria decision model for information system project selection,” Computers & Operations Research, Vol. 22, No. 8, pp. 807–818, 1995.

4. V. S. Lai, K. W. Bo, and W. Cheung, "Group decision making in a multiple criteria environment: A case using the AHP in software selection," European Journal of Op-erational Research, Vol. 137, No. 1, pp. 34–144, 2002. C. C. Wei, C. F. Chien, and M. J. J. Wang, "An AHP- based approach to ERP system selection," International Journal of Production Economics, Vol. 96, No. 1, pp. 47– 62, 2005.
5. J. P. Brans, B. Mareschal, and P. Vincke, "PROMETHEE: A new family of outranking methods in multicriteria analysis," Operational Research, Vol. 3, pp. 477–490. 1984.
6. R. V. Rao, "Decision making in the manufacturing envi-ronment using graph theory and fuzzy multiple attribute decision making methods," Springer-Verlag, London, 2007.
7. R. Santhanam and G. J. Kyparisis, "A multiple criteria decision model for information system project selection," Computers & Operations Research, Vol. 22, No. 8, pp. 807–818, 1995.
8. Dhananjay R. Kalbande and G.T. Thampi, Multi-attribute and Multi-criteria Decision Making Model for technology selection using fuzzy logic, International Journal of Computing Science and Communication Technologies, VOL. 2, NO. 1, July 2009. (ISSN 0974-3375)
9. Journal of Micromechanics and Microengineering, Xuan F Zha and H Du, Manufacturing process and material selection in concurrent collaborativedesign of MEMS devices, 13, 509–522, 2003.
10. Chenhui Shaoa, Kamran Paynabarb, Tae Hyung Kima, Jionghua (Judy) Jinc, S. Jack Hua, J. Patrick Spicerd, Hui Wangd, Jeffrey A. Abelld, Feature selection for manufacturing process monitoring using cross-validation, Journal of Manufacturing Systems, Volume 32, Issue 4, October 2013, Pages 550–555
11. R. V. RAO, T. S. RAJESH, Software Selection in Manufacturing Industries Using a Fuzzy Multiple Criteria Decision Making Method, PROMETHEE, Intelligent Information Management, 2009, 1, 159-165, December 2009
12. Mohammad Akhshabi, A New Fuzzy Multi Criteria Model for Maintenance Policy, Middle-East Journal of Scientific Research 10 (1): 33-38, 2011